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ABSTRACT

A random sample of 225 grade one children were given the Canadian Cognitive Abilities Test (CCAT) on two occasions within seven months. During the second administration the WISC was also administered. KR-20 reliabilities of the CCAT for the two administrations were respectively .83 and .74. The test-retest reliability was .75. The correlation coefficient of the WISC IQ's and the CCAT second administration IQ's was .63. The efficiency and effectiveness indices of the CCAT were also obtained. A factor analysis of the WISC and CCAT subtests indicated that the two instruments measured different constructs. Other useful item data were also obtained. (Author)

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FACTORIAL STRUCTURE, RELIABILITY, VALIDITY, EFFECTIVENESS AND EFFICIENCY OF THE CANADIAN COGNITIVE ABILITIES TEST

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FACTORIAL STRUCTURE, RELIABILITY, VALIDITY, EFFECTIVENESS AND EFFICIENCY OF THE CANADIAN COGNITIVE ABILITIES TEST [1]

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The Cognitive Abilities Test (CAT) is a downward extension of the Lorge-Thorndike test of intelligence for use with Kindergarten to Grade Three. The Canadian Cognitive Abilities Test (CCAT) is essentially the CAT version, but standardized on Canadian samples in Kindergarten and Grades One to Four classes. The CCAT normative samples at each level were substantially large, but very little information is provided on the regional representation of the classes.

There is absolutely no information provided in the test manual on the validity of this test except for the construct validity inferred from a factor analysis. It is reported in the manual that the factor analysis was "based on a matched and representative sample of 300 pupils (p. 26)" in grade 3 all of whom had taken the CCAT and the Canadian Lorge-Thorndike Intelligence Tests, Multi-Level Edition, Level A (CLTIT). However, no information is given on the matching procedure or the particular factor analytic method used. The reported results of the factor analysis were the unrotated factor loadings on three factors, communalities, eigen values, and cumulative percentage of variance accounted for. From these results the authors conclude,

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1 Paper presented at the joint meeting of the AERA and NCME, New Orleans, February, 1973.

"It is quite evident from the first factor that basically what is being measured by all three batteries -- the CCAT and the Canadian Lorge-Thorndike Verbal and Nonverbal Batteries -- is a general reasoning factor (p. 27)." Factor II is tentatively designated a 'verbal' factor. However, the loadings of factor II on the four subsets of the CCAT are negative and on the verbal battery of the CLTIT are positive. This would suggest that the CCAT does not essentially measure the same thing as the verbal battery of the CLTIT. Furthermore, it is almost impossible to make any parsimonious interpretation from the matrix of unrotated factor loadings.

The present study was designed to examine the construct validity, reliability, item difficulties, discrimination indices, effectiveness and efficiency of the CCAT test.

Method

Sample

A random sample of 225 children was drawn from a total of 914 children registered in a Canadian mid-western school jurisdiction.

Procedure

All the children in the sample had taken the CCAT Primary I, Form I in the seventh month of the grade one program. Approximately seven months after the first administration, these children were retested with the CCAT Primary I, Form I and at the same time the WISC was administered. The mean chronological age of the present sample at the time of the post-test was 87.2 months. The Standardization Year II sample mean chronological age was 94.5 months.[2] Since the mean chronological age difference was significant, the

authors felt justified in using the CCAT P1/F1 for the post-test.

Data Analysis

KR-20 reliability coefficients of the CCAT for the first and the second administration were obtained. The stability coefficient between the two administrations was also calculated.

To examine the construct validity of the CCAT an intercorrelation matrix of the four CCAT subscores; Oral Vocabulary (OV), Relational Concepts (RC), Multi-mental (MM), and Quantitative Concepts (QC) and the ten WISC subscores; General Information (I), General Comprehension (CO), Arithmetic (A), Similarities (S), Vocabulary (V), Picture Completion (PC), Picture Arrangement (PA), Block Design (BD), Object Assembly (OA) and Coding (C) was obtained and subjected to a Principal component factor analysis. Four principle components, corresponding to eigenvalues greater than one, were retained, and the resulting factor matrix rotated to a varimax criterion.

The proportion of Ss who answered each item correctly was calculated. This was used as an estimate of item difficulty. The point-biserial correlation coefficients between the item and the total scores were obtained as estimates of discrimination indices.

The efficiency and the effectiveness of the CCAT were determined using the WISC as the criterion instrument. The efficiency of a screening instrument is defined as the percentage of children of given characteristics, as determined by the criterion instrument, compared with the total number identified by the screening instrument. The effectiveness of an instrument is defined as the percentage of all the children with a given characteristic which the instrument locates as compared with the total number of children having this characteristic as determined by the criterion instrument (Pegnate & Birch, 1959).

Results and Discussion

KR-20 reliability coefficients of the test for the first and second administration were respectively 0.83 and 0.74. The stability coefficient was 0.75. The criterion-related validity coefficient based on the correlation between the WISC IQ and the CCAT second administration IQ scores was 0.63. However, the correlations of the CCAT IQ scores with the WISC verbal and performance IQ scores were respectively 0.55 and 0.57.

Since no parsimonious interpretation was possible from the unrotated factor loadings reported in the CCAT, P1/F1, Examiner's Manual (1970, p. 26), these loadings were rotated to varimax criterion. The resulting varimax factor matrix is presented in Table 1. It is evident from these results, that unlike the one

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Insert Table 1 about here

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general reasoning factor inferred from the unrotated factor loadings by the authors of the CCAT, there are three distinct interpretable factors. Factor I is a verbal factor and factor III is a non-verbal factor. It is interesting to note that factor II, on which the CCAT subscores load significantly, is typical of the CCAT only. Thus it appears that whatever the CCAT is measuring, it is independent of what is being measured by the verbal and the nonverbal batteries of the CLTIT. Therefore an examination of the unrotated factor matrix is insufficient to substantiate the construct validity of the test.

The unrotated and the varimax factor loadings of the WISC and the CCAT subscores are given in Table 2. Again an examination of the

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Insert Table 2 about here

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unrotated factor loadings could erroneously be interpretted as one general factor. This is almost always possible in factoring in common factor space using principal components, because the first eigenvalue is the largest in the defined space. However, the varimax rotation of the above matrix gives four interpretable and parsimonious factors. Among these four factors, one factor (III) again is typical of the CCAT only. The other three factors can be labelled verbal, reasoning, and nonverbal respectively. Thus it is evident that the CCAT is measuring something which is independent of that which is being measured by the WISC.

Item difficulties and discrimination indices of the CCAT items for the present sample are given in Tables 3 and 4. Since no data were available in the manual on these indices, it was felt necessary

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Insert Tables 3 and 4 about here

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to examine these indices to evaluate the items of the CCAT. As can be seen from Tables 3 and 4, there are many items in each subtest which are very easy and have no discriminating characteristics. On the other hand, some items, such as item 22 in the Relational Concepts subtest, are very difficult and have again very low discrimination indices. Lack of discriminating power of the various items of the CCAT could be attributed to the use of Primary I instead of Primary II. However, as pointed out earlier, the present sample was, on the average, seven months younger than the standardization sample and the post-test

was administered in the first two months of Grade 2. In any case there appears to be a need for more technical data in order to aid the selection of the appropriate level of the CCAT.

The efficiency and the effectiveness of the CCAT against the WISC as the criterion instrument for the low and high criterion scores are given in Table 5. Both the efficiency and the effectiveness are

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Insert Table 5 about here

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low for this sample. Thus if the CCAT is to be used to identify low and high IQ subjects for referrals, it should be used with caution. It was found for the present sample that to ensure 100% effectiveness the CCAT IQ cutoff points should be 105 and 116 respectively.

From the results of the present study, it would appear that the CCAT requires further refinement, particularly in the lower levels. If the CCAT is going to be used in Canada, it is essential that its users be assured of its validity and reliability. In an era of distrust of intelligence testing and public concern for misuse of intelligence scores, it is extremely important that the measuring instruments used are as free from technical deficiencies as is possible.

References

Pegnato, C. V., & Birch, J. W. Locating gifted children in junior high schools: A comparison of methods. Exceptional Children, 1959, 300-304.

Thorndike, R. L., Hagen, E., Lorge, I., & Wright, E. N. Canadian Cognitive Abilities Test, P1/F1. Toronto: Thomas Nelson & Sons (Canada) Ltd., 1970.

Footnotes

1 Paper presented at the joint meeting of the AERA and NCME, New Orleans, February, 1973.

2 Personal communications with Dr. E. N. Wright.

TABLE 1

Varimax Factor Loadings Obtained from the Unrotated Factor Loadings of 300 Third Grade Pupils from the Standardization Program[1]

Variable	Factor Loadings[2]			
	I	II	III	h^2
CCAT				
Oral Vocabulary	38	49	08	38
Relational Concepts	25	65	19	53
Multi-mental	08	45	33	33
Quantitative Concepts	15	77	29	70
CLTIT				
Multi-Level Verbal				
Vocabulary	76	31	19	72
Sentence Completion	79	12	29	73
Arithmetic Reasoning	47	30	43	49
Verbal Classification	64	23	35	58
Verbal Analogies	64	22	41	63
Multi-Level Nonverbal				
Figure Classification	33	28	64	59
Number Series	32	22	71	65
Figure Analogies	34	33	66	65

1 CCAT P1/F1 Manual, p. 26.

2 Decimal places omitted.

TABLE 2

Factor Loadings[1] of the WISC and the CCAT Subscores

Variable	Unrotated					Rotated (Varimax)			
	h^2	I	II	III	IV	I	II	III	IV
WISC									
General Information	45	66	-10	06	06	46	29	28	28
General Comprehension	67	55	-37	05	48	80	03	17	05
Arithmetic	61	49	18	-56	-14	07	71	24	-18
Similarities	58	60	-29	-37	02	51	56	03	-01
Vocabulary	73	63	-44	-02	38	83	17	11	09
Picture Completion	59	56	-44	27	-09	53	17	-05	[illegible]
Picture Arrangement	55	61	04	-24	-33	11	67	18	23
Block Design	43	54	-06	-15	-35	13	57	07	29
Object Assembly	61	67	-04	12	-39	16	49	18	56
Coding	64	40	-01	61	-34	03	00	17	78
CCAT									
Oral Vocabulary	48	64	20	17	03	24	23	51	32
Relational Concepts	60	57	48	-06	21	13	26	72	-01
Multi-mental	55	42	49	31	21	05	-07	71	20
Quantitative Concepts	66	58	53	-03	20	09	25	77	02

1 Decimal places omitted.

TABLE 3

Frequency Distribution of Item Difficulties of the CCAT

Class Interval	Subtests			
	Oral Vocabulary	Relational Concepts	Multi-mental	Quantitative Concepts
1.0	1,2	4	1,2,3	1
.90 - .99	3,4,5,6,7,8,9	1,2,3,5,6,7,8,9,11,15,19	4,5,6,7,8,9,10	2,3,4,5,6,7,8,11,15
.80 - .89	12,13,19	10,12,14,18	12,15	9,13,14
.70 - .79	10,14	13,16,20	11,13	10
.60 - .69	11,15	17,21	16	12
.50 - .59	17,18	---	---	16
.40 - .49	20	---	---	---
.30 - .39	16,21	---	14	---
.20 - .29	---	---	---	---
.10 - .19	22	22	---	---

TABLE 4

Frequency Distribution of Item Discrimination Indices of the CCAT

Class Interval	Subtests			
	Oral Vocabulary	Relational Concepts	Multi-mental	Quantitative Concepts
.50 - .59	17	21	16	10,16
.40 - .49	10,11,15,16,21	13	--	12
.30 - .39	13,19,20	12,16,17,20	11,13,14	9,13
.20 - .29	12,22	14,18,19	12	6,14,15
.10 - .19	5,6,7,9,14,18	7,11,15,22	7	4,5,7,8,11
.00 - .09	1,2,3,4,8	1,2,3,4,5,6,8,9,10	1,2,3,4,5,6,8,9,10,15	1,2,3

TABLE 5

Efficiency and Effectiveness of CCAT for Identifying Subjects at the Upper and Lower Levels of the WISC IQ Scores

Description	WISC IQ $\leq$ 80	WISC IQ $\geq$ 130
Number correctly identified	2	8
Number missed	2	6
Number incorrectly identified	5	16
Efficiency	28.5%	33.3%
Effectiveness	50.0%	57.1%
CCAT IQ cutoff for 100% effectiveness	105	116